May 2025

DRAFT SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT

Río Puerto Nuevo Flood Control Project
San Juan, Puerto Rico

APPENDIX G: PERTINENT CORRESPONDENCE

U.S. Army Corps of Engineers
Caribbean District

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DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, JACKSONVILLE DISTRICT
701 SAN MARCO BOULEVARD
JACKSONVILLE, FLORIDA 32207-8175

Planning and Policy Division
Environmental Branch

14 April 2023

To Whom It May Concern,

The U.S. Army Corps of Engineers, Jacksonville District (USACE) is beginning the preparation of a Supplemental National Environmental Policy Act (NEPA) document to address design refinements to complete the Rio Puerto Nuevo Flood Damage Reduction Project, San Juan, Puerto Rico (Project), originally authorized in 1986 under the Water Resources Development Act of 1986. Congress allocated funding for construction of the remainder of the authorized project under the 2018 Bipartisan Budget Act (Public Law 115-123) (BBA-18) after Hurricane Maria. The USACE is currently gathering information to define issues and concerns that will be addressed in an analysis to be prepared in compliance with the NEPA.

The Project is located in a densely developed drainage basin with a current population of approximately 12.5 million residents in the San Juan Metropolitan Area along the north coast of Puerto Rico (Figure 1). Flooding is a serious threat to a significant portion of the population and economic activity in the San Juan Metropolitan Area. Congress authorized the construction of the Río Puerto Nuevo Flood Control Project in Section 401(a) of the Water Resource Development Act of 1986 (Public Law 99-662). The purpose of this Project is to offer 100-yr flood damage reduction to the areas adjacent to the Puerto Nuevo Channel. Initial construction of the Project began in 1995 and included the first 1.3 miles of channel improvements, construction of permanent retaining walls, bridge retrofits, and other improvements to the downstream project area (Figure 1). The remaining project is separated into supplemental construction contracts as seen in Figure 1.

The BBA-18 provides funding and authority to complete construction of the remaining features (construction contracts1-7) of the Project at full federal expense to the extent BBA-18 funding is available. The March 2020 Continuing Construction Validation Report outlined the remaining features of the project design to complete the remainder of the project (https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/15300).

Since the project was authorized in 1984, the USACE has supplemented NEPA compliance from the 1984 EIS including a 1992 and 2002 Supplemental Environmental Assessment. The scope of the Project remains essentially the same; however, additional NEPA analysis is needed to evaluate design refinements which may have changed the Projects effects on the human environment. This supplemental NEPA document will focus on the following areas of the Project:

a. replacement of four major existing bridges of the Piñero Avenue Interchange, channel improvements, and construction of a stilling basin (Figures 1-2).

b. the Bechara Industrial Area and Luis Muñoz Marin Park Lagoon which are proposed for material re-handling and placement and staging

The USACE welcomes your scoping comments, views, and information about environmental and cultural resources, project objectives, and important features within the described project area. The USACE will accept written scoping comments regarding the proposed construction of the remainder of the project via email to RioPuertoNuevo@usace.army.mil or by U.S. mail to the letterhead address no later than 30 days from the date of this letter. All individuals who respond with comments will be included in future mailings. Others may be added to the mailing list by making a written request to the same address or by email. All comments will be summarized, addressed, and used to inform the Rio Puerto Nuevo NEPA process.

If you have any questions, please contact Rachel Case (904)232-1035 or via email at Rachel.S.Case@usace.army.mil. Thank you for your assistance.

Sincerely,

Gretchen S. Ehlinger, Ph.D.,
Chief, Environmental Branch

Enclosure

Figure 1. Rio Puerto Nuevo Flood Risk Management Project

RÍO PUERTO NUEVO
Flood Risk Management Project

BACKGROUND

SPONSOR
Puerto Rico Department of Natural and Environmental Resources (DNER)

LOCATION (PROJECT FOOTPRINT)
Metropolitan San Juan, Puerto Rico (Río Puerto Nuevo Drainage Basin, including the Río Piedras Basin and its tributaries)

AUTHORIZATION
Section 202 of the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662)

REMAINING PROJECT COST
$2.654 Billion

FUNDING (REMAINING PROJECT)
100% funded under the Bipartisan Budget Act of 2018 addressing damages from Hurricanes Harvey, Irma, and Maria

HISTORY
The Río Puerto Nuevo Basin drains 26 square miles, 80% of which is highly developed with a population of 150,000. Rapid upstream runoff, inadequate channel capacity, constriction of bridges, and elimination of the floodplain due to urbanization results in severe flooding impacting 7,000 residential structures and 800 commercial and public structures valued at over $3 billion (such as 1.5 square miles of port facilities, government offices, and major water, sewer, transportation, and communication infrastructure).

FLOODING DURING A 2 TO 5-YEAR STORM EVENT

DESCRIPTION OF PROJECT FEATURES
- 6.2 miles of channels of various types
- 2 stilling basins
- 23 new, replaced or modified bridges
- Recreation facilities, such as a bike path, linear path, and pedestrian bridge(s)
- Sewer line modifications, replacements & utility relocations
- Mitigation for loss of habitat

CONTRACT IMPLEMENTATION, FEATURES, AND PROJECT MAP (ALL LOCATIONS ARE APPROXIMATE)

COMPLETED (COST SHARED)

CONTRACTS 1, 1A, 2A/AR, 2AA, 2C1, 2D WALLS
STATUS: 2D Walls, last completed, was May 2022
AMOUNT: $470M
- Kennedy Bridge seismic retrofit; 36-inch water line
- First 1.3 miles of channel improvements
- Quebrada Margarita channel excavation and confluence wall; lower Puerto Nuevo channel dredging
- Bechara Channel secant pile wall box culvert; 90-inch sewer line modification; open channel work
- De Diego Expressway Bridge abutments; east and west pier drill shaft reinforcement
- Quebrada Margarita Stilling Basin
- Construction of 350-foot left channel wall and 750-foot right channel wall at channel confluence.

ONGOING (SUPPLEMENTAL) CONSTRUCTION

CONTRACT - LA CHULETA
- Upland Material Management Area (future capacity of ~350,000 cubic yards of material)

REMAINING (SUPPLEMENTAL) CONSTRUCTION

CONTRACT 1 | UPPER MARGARITA CHANNEL
- Sewer line relocation
- Construction of .63 miles of channel improvements at Upper Quebrada Margarita

CONTRACT 2 | ROOSEVELT BRIDGE
- Roosevelt Avenue Bridge replacement

CONTRACT 3 | MAIN CHANNEL (RIO PIEDRAS)
- Channel walls
- 1.1 miles of Main Channel improvements

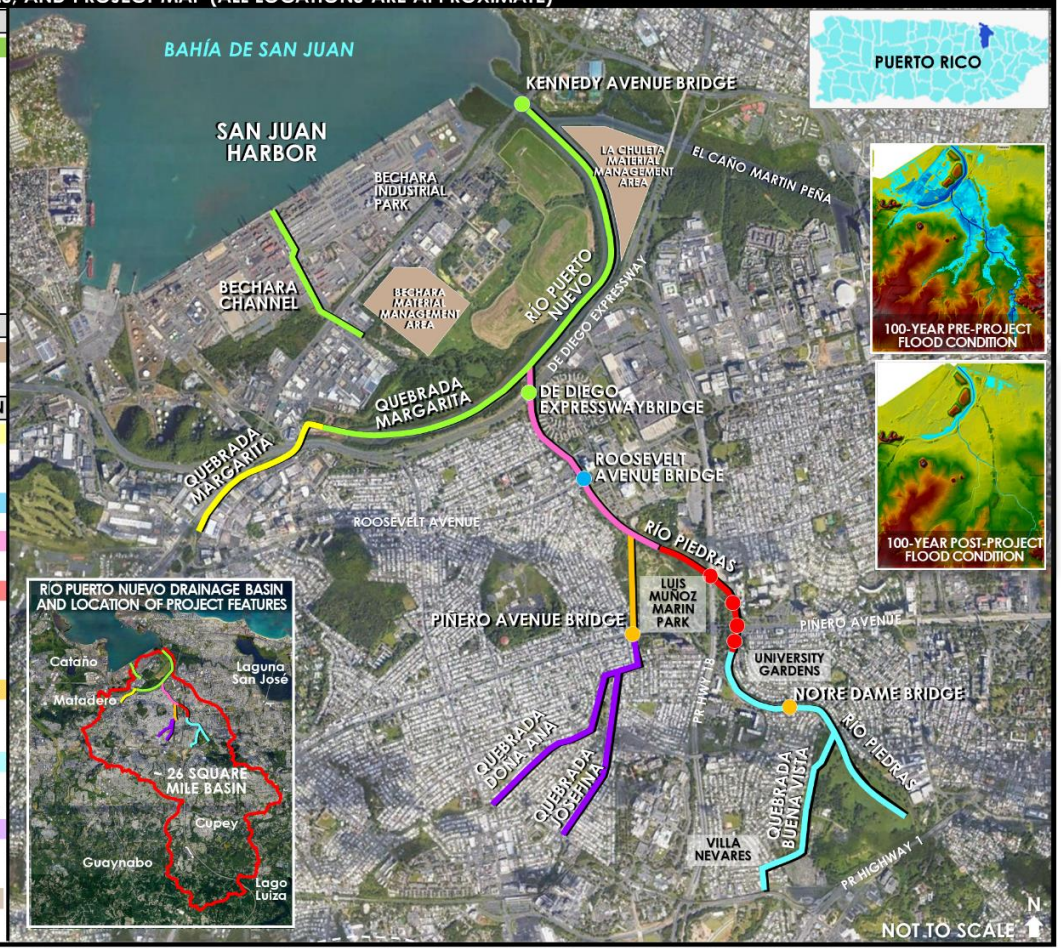
CONTRACT 4 | LAS AMERICAS BRIDGES
- Channel, Stilling Basin and Bridge Replacements
  - 4A-1: Las Americas Expressway Bridge
  - 4A-2: Piñero Avenue Bridge East
  - 4A-3: Northeast Access Ramp Bridge
  - 4A-4: Southeast Access Ramp Bridge

CONTRACT 5 | NOTRE DAME & W. PIÑERO BRIDGE
- 5A: Notre Dame Bridge replacement
- 5B: Piñero Avenue Bridge West replacement; Quebrada Josefina downstream to Río Piedras

CONTRACT 6 | MAIN CHANNEL / BUENA VISTA
- 1.75 miles of Rio Piedras channel improvements
- 4 bridges (2 new; 2 replacements)
- .80 miles channel diversion at Quebrada Buena Vista

CONTRACT 7 | JOSEFINA & DOÑA ANA CHANNEL
- 10 bridge replacements
- 5000 LF. of Quebrada Josefina and 4400 LF. of Quebrada Doña channel improvement

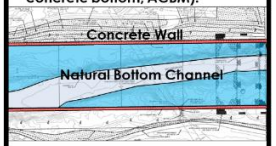
CONTRACT - BECHARA
- Upland Material Management Area (future capacity of ~600,000 cubic yards of material)



RESILIENCE | QUALITY OF LIFE

FLOOD RISK MANAGEMENT
- 100-year storm event
- More than 150,000 people residing in the highly urbanized and densely developed basin
- Over $125 million average annual economic benefits

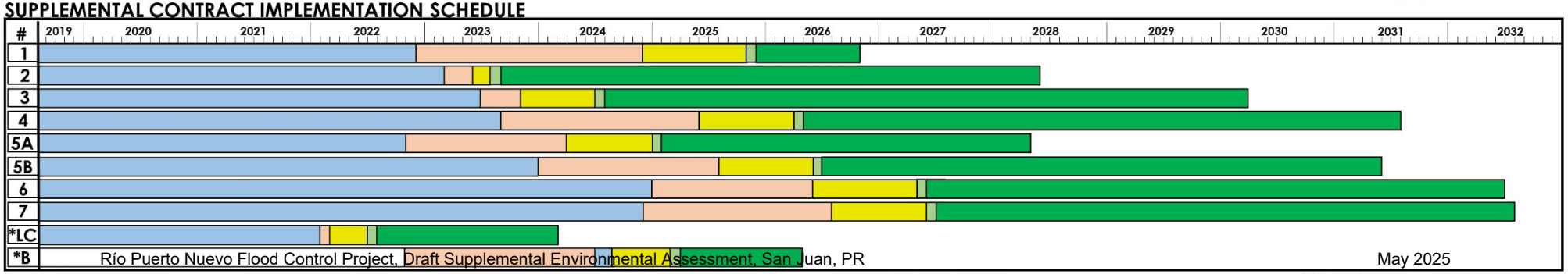
UPDATED INFORMATION/DESIGN
- Stakeholder engagement and updated data/analyses facilitating nature based design modifications such as natural channel bottoms vs. concrete bottom, ACBM).



ENVIRONMENTAL SUCCESSES
- 25+ acres of planted mangroves resulting in wildlife, such as the Antillean Manatee, returning to completed sections of the project.
- Improved sanitary sewer infrastructure reducing discharges into waterbody.

PEDESTRIAN CORRIDORS
- Planned linear parks, bike paths, and pedestrian bridges to increase connectivity across pedestrian corridors.

SUPPLEMENTAL CONTRACT IMPLEMENTATION SCHEDULE



FOR MORE INFORMATION, VISIT: HTTPS://WWW.SAJ.USACE.ARMY.MIL/ABOUT/DIVISIONS-OFFICES/ANTILLES-OFFICE/RIO-PUERTO-NUEVO/

NOVEMBER 2022

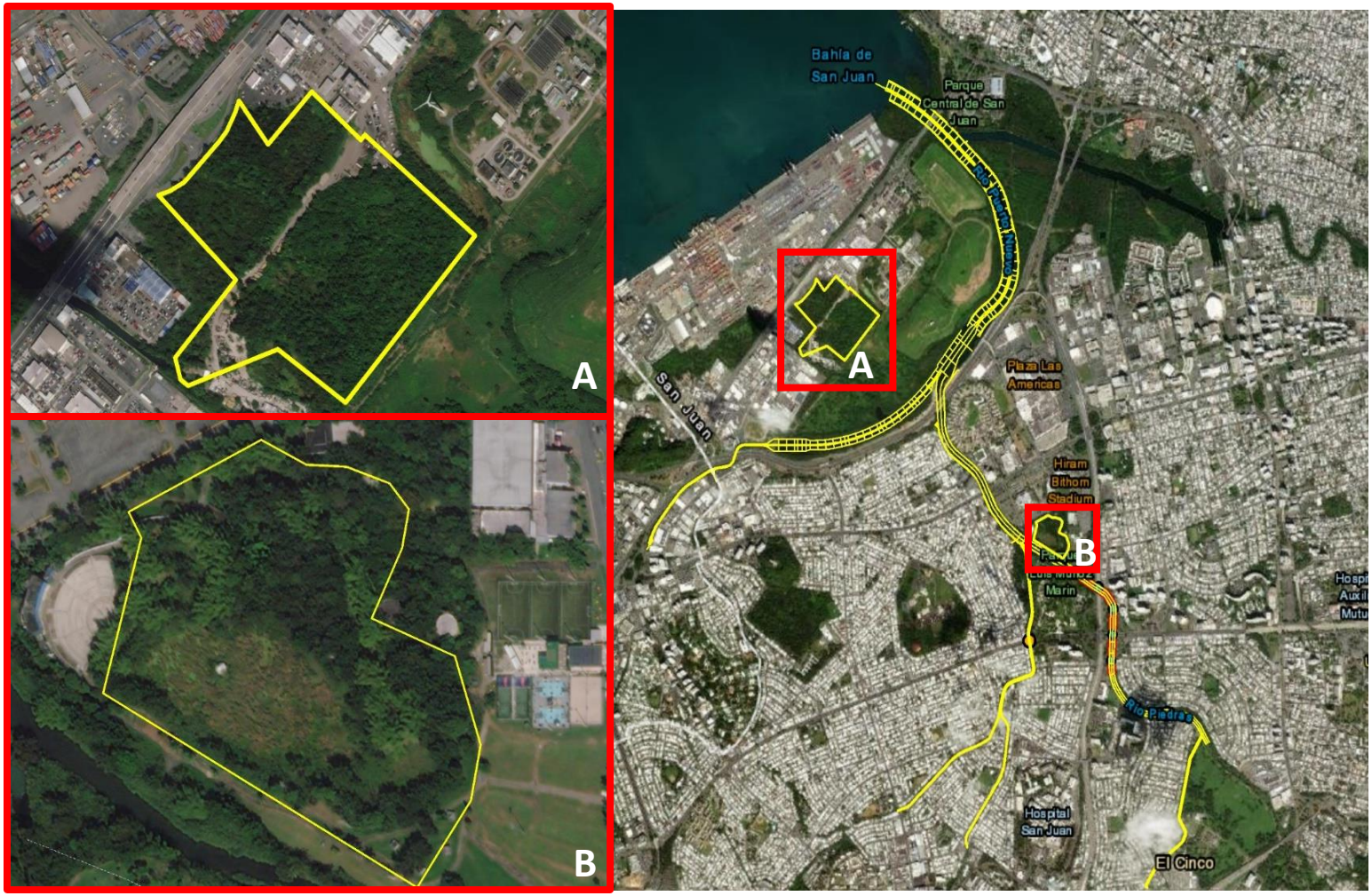


Figure 2. Material re-handling areas/placement area's/staging areas. A) Bechara Industrial Area will be a material re-handling and placement area (Contract award expected March 2025). B) Luis Muñoz Marin Park Lagoon will be a placement and staging area (Contract award expected January 2025).

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May 29, 2023

Gretchen S. Ehlinger, Ph.D.
Chief, Environmental Branch
USACE, Jacksonville, District
701 San Marco Boulevard
Jacksonville, Florida 32207-8175

Dear Dr. Ehlinger,

This is in response to your 18 April 2023 letter asking for public scoping comments regarding the proposed construction of the "remainder" of the Puerto Nuevo project in San Juan, Puerto Rico (from now on 'Project'). This request is based on a NEPA requirement that your agency must comply with. Your letter makes it clear that the scoping comments are to be limited to (a) replacement of four bridges, channel improvements, and construction of a stilling basin and (b) the Bechara Industrial Area and Luis Muñoz Marín Park Lagoon, which are proposed for material re-handling and placing and staging. As this is the first scoping opportunity that I have had for this Project, which was authorized in 1986, I use this opportunity to raise NEPA-related issues that have so far been ignored by your agency.

The statement about the current population of San Juan in your letter (150,000 residents) caught my attention because in the 1984 estimate of the cost-benefit of the Project, your agency stated that the population was expected to rise from 240,122 in 1980 to about 325,000 by 2035. You estimated cost-benefits accordingly. In the post hurricane María revalidation report of A.D. (Jr.) Kelly (reference in the appendix) an eight percent population growth was assumed to 347,052 residents in 2018. This value was also used for cost- benefit estimates and overall justification of the Project. You can understand why the low population estimate in your letter caught my eye. This number captures the problem that your agency is having in justifying this Project whose costs have soared to levels that were difficult to predict in 1984 when the first NEPA analysis was made public.

When the first environmental analysis was made, the Project was justified by the increasing population levels, increasing economic activity, expanding urban cover, and extremely high discharge levels by the Río Piedras (you call it Río Puerto Nuevo). These high levels of population density, economic activity, and discharge rates have been consistently used through the Kelly report. Yet, the actual reality of the watershed has been the opposite of what your agency has been using in documents, i.e., the population has declined sharply, the urban cover had been exaggerated, and the river

discharge was 30 to 40 percent lower than estimated initially by USACE. Thankfully, new staff in your district office has worked with the community to radically modify the nature of the Project. What is being proposed today is dramatically different from what was justified through previous NEPA analyses. However, your agency has refused to conduct a NEPA process that better fits the reality under which huge amounts of federal (public) funds are being spent. Instead, you ask us (the public) to comment on bridges and staging areas, while significant environmental issues remain unattended (see Table 1 below).

Table 1 is based on a comparison of USACE documents prior to 2020 with the Kelly report in 2020. These are the scoping issues that need to be addressed in a NEPA document for the Project as currently designed. Most of these issues have not been analyzed publicly and the Project has been fragmented with construction and design proceeding under the false assumption that contracts have no effects on each other.

Issue raised by Lugo et al. (2013) *	Recognized in Kelly (2020)?	Resolved in Kelly (2020)?
Incorrect assumptions about human population, economics, and land cover.	No, it repeats the assumption	No
Not considering the stormwater infrastructure.	No	No
Asserting water quality would improve with channelization.	Not addressed	No
Expecting that erosion and sedimentation would be minor issues.	Yes, erosion and sedimentation are recognized as a major unaddressed issue	No
Incomplete assessment of the ecological values of the watershed.	No	No
Obsolete benefit to cost ratio.	No, assumes population is growing when it is decreasing. Potential additional and known costs are ignored	No
Not considering climate change.	Yes, but postpones analysis to the future.	No
Not considering sea level rise.	Yes, but postpones analysis to the future	No
Not considering the worst-case scenario for channel discharge into San Juan Bay.	No	No
Incorrect assumptions about human population, economics, and land cover.	No, continues to assume rosy scenarios	No

*The reader is referred to Lugo et al. (2013) for the technical arguments of why these issues are important to Project design, benefit cost analysis, and functional effectiveness.

Each of the ten issues in Table 1 are significant and influence not only the environment but the cost of the Project. The next table below summarizes the historic cost-benefit of the project based on your public documents.

What the USACE has reported as benefit to cost ratio for the Río Piedras channelization.

Year/Alternative	Benefits (B)	Costs (C)	B/C
1984	659,100,000	253,500,000	2.6
1991	728,400,000	303,500,000	2.4
2020/1	2,480,000,000	2,217,000,000*	1.1
2020/3	2,416,258,620	1,579,254,000*	1.5

*Sunk costs of $420 million not included in the cost estimate.

It is not clear to the public how the benefits of the Project multiply significantly despite a lowering in population and an equally precipitous decline in economic activity (Puerto Rico went bankrupt). It is also unknown what the current benefit-cost of the Project is, because there appears to be a sense that Congress has given a green light to use new funding without regards to prudent use of public resources. I strongly suggest that the NEPA exercise includes a realistic and well-documented cost-benefit analysis. If the cost to benefit ratio is below 1, it should be so disclosed, particularly considering the congressional mandate that you received after hurricane María.

I conclude my letter with several issues with significant environmental effects that have yet to be publicly disclosed through a NEPA analysis.

- **Sediments**. It is a known fact that rivers in Puerto Rico carry high sediment loads during peak flow events. For the Río Piedras, peak sediment fluxes have been measured at about 100,000 tons per day. After hurricane María, USACE estimated 440,000 cubic yards of sedimentation within the completed lower channels. The blockage from sediment in those channels resulted in a conveyance area reduction ranging between 20 and 46 percent in the Río Piedras just downstream of the confluence wall. The public does not know the cost of the emergency repairs that USACE ordered, but this will be a recurrent maintenance cost that the Commonwealth of Puerto Rico will have to cover in the future. Knowing that the Commonwealth does not maintain other USCE projects, such as Río Bayamon or Río Bucaná, NEPA scoping should disclose issues that affect the future maintenance cost, plus the health and safety of populations living next to these water bodies. Also important is the role of the Project in accelerating sediment movement towards the estuary and the sedimentation of lower channels. This is an environmental process that requires discussion of its ecological effects on the biota. The issue of sedimentation of the estuary also affects other USACE projects in San Juan, which are discussed next.

- **Other USACE projects in San Juan Bay**. Your agency is also responsible for the dredging of San Juan Bay, a critical water body for the economic health of Puerto Rico. The Project merged the Río Piedras with the Caño Martín Peña where USACE also has a major restoration project. The dredging of the Bay is locally sponsored by the Puerto Rico Ports Authority, the Caño Martín Peña restoration is sponsored by ENLACE (a corporation formed for that purpose), and the Project by the Department of Natural Resources and the Environment. Three projects, three local sponsors, one location where they all merge and affect each

other, and zero coordination. I would think that a NEPA exercise would consider the interaction of three major federal projects funded through one agency (USACE). They have a common hydrology, a common biota, and a common ecological functioning. How can they be successfully completed if there is no coordination of causes and effects?

- **Sea level rise**. The public has not seen the analysis of the effects of sea level rise on this Project. The one ecological issue that merits attention is the salinization of the estuary, particularly at low flows. It is known that channelization dries watersheds because it exports excess water during rainfall events, isolates the river from surrounding riparian systems, and no source of steady freshwater is available during droughts. Normally, natural rivers maintain a low but steady flow of freshwater during the dry season. The Project can reduce flow during droughts and increase the salinization of the estuary. What are the effects of this change on the biota? A sound NEPA analysis will consider this effect, particularly under a sea level rise scenario. While your engineers have overdesigned the Project to consider increased sea level, no analysis of sea level rise on the biota has been undertaken nor on the landward distance of seawater incursion, including potential effects on local freshwater aquifers.

- **University of Puerto Rico Botanical Gardens**. Experimental agricultural lands in the Botanical Garden are being considered for the re-routing of quebrada Buena Vista, presumably because fixing the channel of the quebrada *in situ* is too expensive. Your proposal is to affect public lands used for long-term educational and research purposes while living the old channel to deteriorate and contribute to the degradation of a community that is underrepresented, aging, and of low economic status (a social justice issue). Your NEPA process should analyze this social-ecological issue, particularly considering the high funding level that Congress bestowed on your agency.

Finally, the channelization Project, over its long history, has consistently used obsolete or erroneous information to justify a hydrological design that was out of proportion with its social-ecological context. As your agency became more open to listening to others, particularly the affected communities and independent scientists, the Project design changed dramatically. I and others believe that the design can be further improved, but to do so a stronger analysis is needed. The NEPA process allows for such an effort, but only if it is not fragmented. We need a new holistic look at this Project. It is a Project that runs through the center of the capital city of Puerto Rico and affects other USACE projects in the same location. This NEPA process is probably the last opportunity to add common sense to a gigantic and important project. Done right, it can serve as a model to other equally impactful projects that Congress authorized for this island.

Ariel E. Lugo
Emeritus Scientist
USDA Forest Service
International Institute of Tropical Forestry

Appendix 1. My analysis of the Kelly Report validating the continuation of the channelization of the Río Piedras. This was done in June 2020. I retired from federal service since then.

RÍO PUERTO NUEVO FLOOD CONTROL PROJECT PUERTO RICO CONTINUING CONSTRUCTION VALIDATION REPORT: SUMMARY AND EVALUATION

Ariel E. Lugo
International Institute of Tropical Forestry
USDA Forest Service
Ceiba 2500, Jardín Botánico sur, Río Piedras, PR 00926-1115

INTRODUCTION

This is an analysis of the contents of the Continuing Construction Validation report (Kelly 2020) for the channelization of the Río Piedras[1] (from now on referred as the project) by the United States Army Corps of Engineers (USCOE). This report has three main parts. First, an objective depiction of the contents of the Kelly report. Second, an interpretation of the contents with attention to unresolved issues and implications to the viability of the project. Finally, recommendations for actions needed to overcome the limitations of the USCOE approach in this project. The main conclusion of my analysis is that the USCOE has not established the viability of this project and the likely outcome could be the waste of taxpayers' money. For a history of the project as captured in official documents of the USCOE, refer to Lugo et al. (2013).

PART I. CONTENTS OF THE KELLY REPORT

Executive Summary

The report recommends a re-scoped strategy for implementing the project that reflects changed conditions and cost increases that have ensued since original project authorization. It optimizes the economic efficiency of the project. The Chief of Engineers has the discretionary authority to proceed with the recommendations without any further consideration from Congress. The project has the opportunity to continue given the authorization of the Bipartisan Budget Act of 2018 (P.L. 115-123 (BBA). The report seeks to establish that the remaining features of the project are environmentally acceptable, economically justified, and feasible from an engineering and design point of view.

The original authorization in 1986 was for $234 million dollars. The population of the río Piedras watershed is estimated at 151,000 residents. The authorized activities for the project includes concrete sheet pilings, planted mangroves, trapezoidal earth channel lined with rip rap and mangroves, concrete rectangular channel improvements, silting and debris basins, all bridge relocations along the main river (except the Constitution and de

[1] The US Corps of Engineers continues to confuse the río Piedras with río Puerto Nuevo. The report has two maps with contradictory information, one (Fig. 1) labeling the river correctly as río Piedras, the other doing so incorrectly as río Puerto Nuevo (Fig. ES-1). Consult Lugo et al (2011) for historic map documentation of the Corps mistaken identity for the river. I will use the correct designation of río Piedras.

Diego bridges), and the relocation of approximately 18 structures. The plan also authorizes channel improvements and bridge relocations to the main tributaries: quebrada Margarita, quebrada Josefina, quebrada Doña Ana, quebrada Buena Vista, and quebrada Guarancanal. The authorized plan also includes recreation improvements as well as mitigation in the form of mangrove planting. Figure ES-1 in the report has a map of the original project features and landmarks.

The passage of hurricane María caused record rains and flooding in the project's watershed. Sediment deposition within the project was of significant concern. The capacity of the USGS stream gaging station 50049100 at the Piñero Avenue bridge was exceeded. Estimated peak flow at this site was not available to the report authors, but high-water marks were measured at 3.31 feet above ground just south of F.D. Roosevelt Avenue bridge, 3.51 feet above ground at Calle Alsacia of Puerto Nuevo, and 2.26 feet aboveground just upstream from the confluence of quebrada Doña Ana and Josefina tributaries. Table ES-1 of the report contains the status of all contracts associated with the project and Fig. 2 in the report has the geographic distribution of each contract.

The economic aspect of the project are summarized in Table ES-3 of the report, which contains the assumptions, costs, benefits, and benefit to cost ratio. Assumptions include using a discount rate of 2.875 percent, and a 50-year period of analysis. Dollars are estimated on an annual basis to October 2015 price level for both costs and benefits. The numbers in the executive summary do not coincide exactly with the numbers in Table ES-3[2]. The executive summary contains the following approximate costs and benefits: Remaining costs (without sunk cost) to complete full construction of the authorized project in FY 19 dollars is 1.864 B or 2.217 B fully funded. Therefore, three strategies were developed for completing the project, which involved changes to the initial authorization.

Strategy 1 completes the project as designed in ten years. The fully funded cost for strategy 1 is $2.217 billion (without sunk cost) and a completion date of 2031. This strategy has a benefit/cost of 1.12. The average annual NED (National Economic Development account) cost based on October 2015 price levels is $105 million and the total average annual benefit is $125 million.

Strategy 2 evaluates expedited construction of the entire authorized project with a four-year completion date. Because of numerous potential obstacles and greater cost of construction, this strategy was not evaluated or considered further. It would have increased the cost of the project one order of magnitude.

Strategy 3 is the recommended strategy. It completes 97 percent of the authorized project. It overcomes the insufficient funding available from Congress to complete the whole project and addresses changes that have occurred in the basin since the project was authorized. It completes construction of supplemental contracts 1 to 7 in Table ES-1 and desists from contract 8, which appears not to be economically nor technically justified. The fully funded cost of strategy 3 is $1,579,254,000 without sunk costs. Obligations would be completed by 2025 and construction ended by 2032 with a benefit to cost ratio of 1.53.

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[2] I infer that the reason why the numbers in the cost benefit Table ES-3 are not the same as in Table ES-2 is because the cost benefit table includes calculations of discount rates, and a 50-year period of analysis, plus other transformations that are not clear to the public like me.

The average annual NED cost at October 2019 price levels is $74 million and the total average annual benefits at the corresponding price levels are $120 million.

The costs of strategies 1 and 3 are the sum of the cost of each individual supplemental contract (Table E-2 of the report). The difference in the total cost is accounted by not funding supplemental contract 8. The sunk cost is $420 million per TPCS (not defined; could be for each strategy). In the calculation of the benefit cost ratio, benefits are those previously estimated. They include primary average annual benefits (flood risk management at October 2015 price levels) of $124,153,000 and 119,758,000 for strategies 1 and 3 respectively, and incidental average annual recreation benefits of $1,089,000 for both strategies.

The project is deemed in compliance with all applicable environmental laws and thus no additional NEPA (National Environmental Policy Act) analysis since the 2002 Environmental Assessment is needed. If strategy 3 requires future design refinements, those might require supplemental NEPA evaluation.

Study Overview

Total project first cost is $2.28 billion including sunk costs and obligated funds to date. The fully funded cost is $2.637 billion. Without sunk cost, the respective quantities are $1.865 billion and $2.217 billion.

Section 1.2. The report recognizes that the main river is the río Piedras and provides a map, Figure 1 in the Kelly report, that contradicts its own Figure ES-1. This short and enlightened statement is quickly ignored in the rest of the text and report figures.

The authorized project consists of improvements to 11.2 miles of río Piedras and its tributaries, including 1.66 miles of concrete-lined trapezoidal channel, 9.54 miles of concrete-lined channel (5.1 miles of which are high velocity or supercritical flow[3]) and 2,160 feet of double box culverts. Also included are two baffle pier stilling areas, two high velocity confluences with tributary streams Buena Vista diversion channel and Guarancanal channel, two upstream debris basins with side overflow or lateral spillways, and other project relocations, including bridge replacements and modifications. There are several recreation features such as a walking trail and a boat ramp. Complexity is increased by the presence of all three of the city's inflows to the regional sewage treatment plant and its outfall lines. The project also affects the city's principal power and water supplies, gas lines, sanitary sewer lines, secondary storm sewer lines, highway bridges, and telephone, fiber optics, and cable television lines.

Section 1.3. The original benefit to cost ratio in 1986 was 2.6 to 1. In 1991, the ratio was 2.4 to 1. By 2011 it was concluded that the total project cost had exceeded the authorized 902 limit, i.e., the project had exceeded the maximum amount that a project may cost. A post authorization report to seek additional funds was not endorsed by the South Atlantic Division office in 2014. Another round of reports to overcome the shortage of funds was also rejected but eventually overruled by Congressional action after hurricane María.

[3] The report does not indicate if supercritical flow channels will be elevated channels as originally proposed.

Section 1.4. The Department of Natural Resources and the Environment (DNRE) continues to be the project sponsor.

Section 1.5. All bridges over the main river will be replaced with the exception of the Constitution and the De Diego bridges. To protect the Norzagaray bridge, the channel will be diverted some 115 m (0.07 miles) to the west and a new PR-1 bridge will be constructed. Bridges to be replaced are the Roosevelt Avenue, Las Americas expressway and its two eastern ramps, the J.T. Piñero, the Notre Dame, and the PR 176 Hwy bridge. Some 18 structures will be relocated.

In the description of the various segments of the project, the report mentions 'physical model tests' used to evaluate designs. Results and assumptions for those tests are not reported. However, the notion of the Buena Vista Diversion Channel is presented as a permanent improvement that eliminated the need for extensive loss of home sites along quebrada Buena Vista. This is a new alignment for the channel excavated through an undeveloped area near the University of Puerto Rico Agricultural Experiment Station and the proposed Botanical Gardens[4]. Such diversion will have a high velocity confluence with the main channel. The same is true for the Guarancanal channel at its confluence with the río Piedras channel, i.e., high velocity confluence.

Design features such as planters, rest stops, benches and the path surface will be used to achieve maximum compatibility. Screening the channel through the use of berms, fencing materials, and plants will be done to reduce its visibility and increase its acceptability to the local population.

Section 1.5.1. The items of local cooperation, i.e., the responsibility of the government of Puerto Rico, have been modified (updated) in accordance with a February 20, 2019, Project Cooperation Agreement Amendment 1. The items are:

1. Provide a cash contribution equal to 5 percent of the total project costs.
2. Provide all lands, easements, rights of way, relocations, and dredged material disposal areas (LERRD).
3. Provide an additional cash payment when the sum of items 1 and 2 are less than 25 percent of the total project costs.
4. Operate and maintain the project after completion, including accomplishment of any need replacement or rehabilitation of any of its components (OMR&R).
5. Hold and save the US free from damages due to the construction or subsequent maintenance of the project, expect damages due to the fault or negligence of the US or its contractors.
6. Prevent future encroachments which might interfere with proper functioning of the project.
7. Participate in and comply with applicable Federal floodplain management and flood insurance programs pursuant to public law 99-662; and
8. Provide guidance and leadership to prevent unwise future developments in the floodplain.

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[4] This is an erroneous statement as the University of Puerto Rico Botanical Gardens was established in 1971, well before the USCOE began the channelization project for the río Piedras.

Section 1.5.2. Total LERRD costs are 36,610,000 or 12 percent of the total flood control cost of the project. Puerto Rico has to contribute $15,164,200 in cash plus all the cost of the LERRD, plus a share in the cost for recreation cost ($232,000). Total PR share is $75,966.000 based on the 1991 General Design Memorandum (GDM).

Section 1.6. Total sunk cost is equivalent to obligated funds and was $420 million as of October 2019. Included in those costs are preconstruction, engineering and design (PED), construction, LERRD's, and other associated costs. Figure 1 of this summary contains the history of federal funding for the channelization project since it was authorized.

Overview of Changed Conditions Since Authorization

Section 2.2. Between 1986 and 2018 there has been a net population and economic increase in the project area. The population of Puerto Rico increased from 3 million to 3.66 million (7.6 percent) and of San Juan from 319,068 to 347,052 (8.8 percent). Dozens of new commercial properties, hundreds of new residential properties, and a number of unique structures have been constructed, including Plaza las Americas and the San Juan Natatorium. The 55,000 structures have a total depreciated exposure value of $14.6 billion, 90 percent ($13.2 billion) being residential, 9 percent ($1.32 billion) commercial, and 1 percent ($84 million) public buildings. The average value of residential structures was $194,000, for multifamily residential structure it was $386,000, for commercial structure it was $356,000, and for public structures $177,000. The overall structure value was $238,000. About 70,000 people live in first floor elevation equal or lower than the elevation associated with the 100-year event. For structures with elevations equal or lower than the 250-year event, the population is 80,000. Based on the 2010 census, the average household had 2.68 persons, and multifamily units contained 30 units. Life loss was not estimated the estimates for economic justifications are based on reduced damages. The average flooding above the first-floor elevation is equal to 1.78 feet; 935 structures have flood depths greater than three feet.

Section 2.3. Contains engineering conditions and changes as a result of alteration of hydrologic conditions in the city. The analysis is done by contract number. The old natural río Piedras channel that entered directly into San Juan Harbor, is now known as the Bechara Canal. The project will comply with all USACE regulations, policies, and community of practice standards. Therefore, the following five items need to be addressed but are not now available:

1. Update rainfall depth and distribution analyses, adding the 200-yr return interval level.
2. Update hydraulic routing of flood flows; use two-dimensional (instead of 1-dimensional as before) routing models for supercritical flows. Include a new hydrographic survey will be required to account for aggradation and erosion of sediment over the years since last modeled for design purposes.
3. Investigate sea level rise through model sensitivity analyses.
4. Results from H & H analyses to be used for NEPA updates, if needed.
5. Redraw new flood maps (residual floods) for popular knowledge and future use.

Section 2.4. This is a section on how sea level change and climate change will be analyzed. It addresses the use of the USACE web-based sea level change calculator. This section describes current USACE procedures with this topic and points out that normally these issues are addressed at the end of the 50-year and 100-year project life cycles.

Performance of the Project and Impacts of Hurricane María

Hydrographic surveys indicated that the eroded sediment suspended in the flow settled out in the channel downstream of the De Diego bridges, both in the río Piedras and Margarita channels. This caused uncompleted portions of the channels to fail to provide the authorized level of flood damage reduction benefits as a result of a 100-year event. Further sedimentation is expected from other storm events, which reduce the hydraulic capacity of channels and reduce their flood control benefits. After hurricane María, they estimated 440,000 cubic yards of sedimentation within the completed lower channels. The blockage from sediment in those channels results in a conveyance area reduction ranging between 20 and 46 percent in the río Piedras just downstream of the confluence wall. Emergency repairs were ordered.

Environmental Conditions

This section describes the USACE reasoning for asserting the lack of environmental impact of the project and their efforts to mitigate and comply with environmental laws and regulations.

Economic Analysis for the Total Authorized Project

Section 5.1. The significant increase in the cost of the project is due to various reasons. One is inflation. The original cost in current price levels is $528,593,000 or 23 percent of the current cost. The rest of the increase is due to weather effects, construction issues, real estate cost increases, changed designed standards, unknown underground utilities, and changed site conditions.

Section 5.1.2. Risk analysis resulted in a contingency of approximately $418,883,000, reflecting contingencies for both cost and schedule risk analyses. The most significant cost risk driver was the design development stage and historic change order or modification growth (accounting for 21.1 to 22.4 percent of the statistical cost estimate variance). Part of the problem is that the design was developed using a General Design Memorandum developed in 1991, which did not capture the conditions of the project area. Acquisition planning to accommodate funding stream and Relocations may not happen in time contributed 43.7 percent and 17.1 percent of the statistical cost estimate variance.

Section 5.2 deals with real estate costs including lands, easements, rights of way, relocations, and disposal sites (LERRDs). The estimated cost of lands, easements and rights-of-ways (LER) included in the 2015 gross appraisal is $545 million without contingency with $327 million accounted by completed features. The SAJ PB-3 estimate for LER was $25.3 based on the 1991 General design Memorandum and escalated to 2015. All future LER contracts are estimated to be approximately $287.5 million including $15.4

million for contingency. $139.4 million are estimated for relocations and $178.6 million for roads and bridges.

Section 5.3 details the economic update of the project, including modeling (economic and hydrologic), and estimates of damage with and without the project.

Section 5.3.3 and 5.3.4. Benefits have been recalculated and updated, and generally increased with the inclusion of the walking trail and boat ramp. $40.8 million in benefits during construction, $1,089,000 in recreation benefits.

Section 5.3.5. The project will generate an estimated $796,950 million in interests between 1995 to 2032, of which $344.95 are sunk.

Risk and Uncertainty

This relatively long part of the study addresses risk and uncertainty from a variety of perspectives. The narrative makes clear that the validation report is an internal document that does not analyze different project alternatives and does reformulate of the ongoing project. No study risk is associated with this effort. The risks analyzed include economic risks, real estate risks, and outcome risks. Uncertainties include the estimates of damages to structures and vehicles, uncertainty in elevation measurements using LIDAR, uncertainty in the estimates of the content to structure value ratio, and so on. As an example, the ten-bullet section 6.3.1 on the uncertainties in the engineering analysis includes the deterioration of existing structures, the effects on design and construction of the H & H analysis update, and the risk of the effects of climate change and sea level rise. The report asserts that the identified risks and uncertainties are low and will be addressed in the engineering design (PED) phases. Problems with the real estate laws of Puerto Rico, and their lack of familiarity by the federal agency, are identified as risks, as they delay actions and contract delivery. Similarly, locating owners dispersed by the hurricanes of 2017 are also causes of concern. The various bulleted lists are enlightening and include the sluggish progress of contractors that so far have taken longer than expected to complete those contracts associated with the beginning of the project. The report states that without the completion of contracts two to seven, only 11 percent of the flood damage to 70,000 people will be mitigated. In other words, without the project, they expect that $112.5 million in damages will remain in the basin. With the project, the vast majority of the 70,000 people will no longer be at risk of flooding even by the 250-year event.

Implementation Strategies

Details of the three strategies described above are given in this part of the report, including a sub-basin by sub-basin damages assessment and benefits with and without the project, The project subdivided the river basin into 24 sub-basins to analyze project costs and benefits and display the areas covered by each contract. In the recommended strategy 3, contract 8 is eliminated except the part dealing with the debris basin within University of Puerto Rico's lands, which is now part of contract 6. By eliminating contract 8, the Old Aqueduct at the University of Puerto Rico Agriculture Experiment Station is protected.

Section 7.2. This section itemizes amendments to the cooperation agreements with the Commonwealth. This is a section of the report that outlines the responsibilities of the Commonwealth and its Department of Natural Resources and the Environment with the project.

Recommendation

The report ends with the recommendation of proceeding with the río Piedras flood control project utilizing strategy 3, the re-scoped project shown in their Figure 5. "...the re-scoped project would be deemed complete as the functional elements identified for construction are economically justified, technically feasible and environmentally acceptable and are within the discretion of the Chief's authority" (p 78). Figure 5, page 77, in the report shows the new debris basin and deviation of the river channel affecting the lands of Jardín Botánico norte.

PART II. INTERPRETATION OF THE KELLY REPORT

The Kelly report makes it clear that its objective is not to re-analyze the technical basis that justify a project in progress. However, the content of the Kelly report addresses all the subjects that concerned Lugo et al. (2013), even if it does not resolve them. Moreover, Kelly (2020) addresses (without resolving and assuming they are all minor) uncertainty and risk factors not addressed before by the USCOE in documents for this project. The section on risks and uncertainty is a welcome addition to public disclosure regarding this project. However, without close examination of available data and assumptions used, it remains to be established that the rosy scenario presented in part 6 of the report is the correct one. Nevertheless, the Kelly report provides a new benchmark for a critical analysis of a project that is important for the city of San Juan and its future resilience in light of a changing social-ecological-and technological environment.

Benefit to Cost Estimate

Before entering an interpretation of the Kelly report, the issue of the high cost of the project deserves attention. The initial estimated cost of the project was $234 million and according to the Kelly report, the revised fully funded cost is $2.637 billion with sunk costs included. This new estimate is over eleven times higher than the original cost. Kelly attributes 23 percent of the increased cost to inflation, leaving about 80 percent of the increased costs unexplained. By 2011, the project had exceeded the maximum cost that a project can cost under current regulation. Twice after that milestone, the project request for additional funding was rejected, effectively terminating the project. One of the many possible causes for the over expenditures in this project was the Designed Memorandum of 1991. The Monte Carlo simulation discussed in section 5.1.2 revealed that the General Design Memorandum of 1991, upon which the project was conceptualized, failed to capture conditions in the project area. This simulation validates the public statements that were raised in Lugo et al. (2013) but not listened to by the USACE. Moreover, section 5.2 shows additional problems with estimate of real estate costs between the 2015 gross appraisal and the SAJ PB-3 cost based on the 1991 General Design Memorandum. These large discrepancies create uncertainty in the accuracy or reality of past and present estimates used to justify the project.

The project design failed to consider the sedimentation problem, for which there were data available (Lugo et al. 2011). Hurricane María deposited 440,000 cubic yards of sediment on the completed portion of the channelization project and reduced channel effectiveness by 46 percent. Such events will occur many times in the upcoming decades and will erode the economic basis of the project as well as its hydrological effectiveness.

After the passage of hurricane María, the US Congress was generous with its appropriations and allowed the project to ignore its woes with the high costs of controlling a tropical river. I argue that the items that the USCOE ignored in the past, and that now the Kelly report glosses over for future consideration, are partially responsible for cost overruns and influence the future effectiveness of the project. The rate of expenditure after hurricane María has increased sharply (Fig. 1) and is bound continue to increase even more as the project encounters all the issues that its planners have so far ignored. The benefit cost ratio of the project has steadily declined since 1984 (Table below) is lower than before and one has to wonder how is possible for benefits to continue to climb in a basin with a depress economy and reduced population density. The USCOE may find itself managing a project with greater costs than benefits as it continues to push a project designed for a river basin that no longer exists in terms of its social and ecological conditions.

What the USCOE has reported as benefit to cost ratio for the río Piedras channelization.

Year/Alternative	Benefits (B)	Costs (C)	B/C
1984	659,100,000	253,500,000	2.6
1991	728,400,000	303,500,000	2.4
2020/1	2,480,000,000	2,217,000,000*	1.1
2020/3	2,416,258,620	1,579,254,000*	1.5

*Sunk costs of $420 million not included in the cost estimate.

Issues Not Addressed and Deferred to the Future

A review of USCOE documents regarding the río Piedras channelization project identified nine issues that were poorly attended by the USCOE and which could hinder the effectiveness of the project if left unattended (Lugo et al. (2013). The listing of risks and uncertainties in Kelly (2020) validates several of the issues raised by Lugo et al. (2013), but does not evaluate them, passing on the future a comprehensive evaluation of the project. The Kelly (2020) report repeats some of the previous misconceptions used to justify the project and leaves unexplained some of the details of the benefit to cost ratio calculation. In spite of the uncertainty and identified risks, the Kelly report re-scopes the project and recommends a strategy for its completion.

As an example of the problem with the approach in Kelly (2020), consider the analysis of the population within the river watershed. This analysis is critical for the benefit cost calculation, because more people and structures mean greater flood control benefits and a higher benefit to cost ratio. Kelly uses population data for 2010, ignoring what has happened in San Juan and Puerto Rico since that time. Therefore, the benefit to cost ratio is based on a growing urban population and striving economic activity. In fact, population and economic activity were thriving between the 1980s and 2010. But between 2010 and today, the population has declines significantly as has the economic activity in the river

basin. By using population extrapolations based on a trend that no longer exists in the basin, Kelly (2020) is inflating the benefits and need of the project. The issue of using the wrong population extrapolation was diagramed in Fig. 6 of Lugo et al. (2013) and should not be news to the USCOE.

Another example is how the hydrology of the basin is dealt with. Given all the hydrological changes that have occurred in the basin since the project was authorized, as well as expected future changes, there is a need to update hydrology and hydraulic (H & H) studies to assure effective PED's (engineering designs). This is recognized by Kelly (2020), but none H & H analyses have been conducted and all are delayed to the future, when they could likely cause dramatic changes in design, costs, and benefits.

The section on sea level and climate change is a welcome addition to USCOE documents dealing with this project. However, the discussion in that section of the report (section 2.4) appears tentative and not completely convincing. About 50 years will have pass between the time the project was authorized and its projected completion (1986 to 2032). The original project design had no consideration of sea level change, and none has been added, including in this report. It is imperative to consider critical changes in hydrology, climate, and sea levels before any more resources are committed to the original design.

I recognize that Kelly (2020) is not a technical analysis of the project, but it validates many of the concerns expressed earlier by simply mentioning them. In my evaluation, I recognize the value of the disclosures in the Kelly report, but also point out that unless technically considered, these issues remain as obstacles to the successful completion of the project. The issues raised by Lugo et al. (2013) and how Kelly dealt with them are listed in the following table.

Issue raised by Lugo et al. (2013)*	Recognized in Kelly (2020)?	Resolved in Kelly (2020)?
Incorrect assumptions about human population, economics, and land cover.	No, it repeats the assumption	No
Not considering the stormwater infrastructure.	No	No
Asserting water quality would improve with channelization.	Not addressed	No
Expecting that erosion and sedimentation would be minor issues.	Yes, erosion and sedimentation are recognized as a major unaddressed issue	No
Incomplete assessment of the ecological values of the watershed.	No	No
Obsolete benefit to cost ratio.	No, assumes population is growing when it is decreasing. Potential	No

	additional and known costs are ignored	
Not considering climate change.	Yes, but postpones analysis to the future.	No
Not considering sea level rise.	Yes, but postpones analysis to the future	No
Not considering the worst-case scenario for channel discharge into San Juan Bay.	No	No
Incorrect assumptions about human population, economics, and land cover.	No, continues to assume rosy scenarios	No

*The reader is referred to Lugo et al. (2013) for the technical arguments of why these issues are important to project design, benefit cost analysis, and functional effectiveness.

Other Issues

Although hurricane María provided the justification for the funds to rescope and re-start the project, the reanalysis was done without definitive information about the actual effects of hurricane María. Perhaps as a precaution, the analysis added the 200-year event level to the analysis.

It is not clear how the diversion of the channel to protect the Norzagaray bridge will affect University lands, other lands, and the DNRE building. Lands from the University of Puerto Rico are affected with the new design and the addition of the quebrada Buena Vista diversion, plus the diversion of the río Piedras to avoid the Old Aqueduct.

The effort to screen the concrete channel suggests that as proposed earlier, the channel will be elevated from the ground surface to achieve super critical flow. This item is not disclosed in Kelly (2020) and requires a clear response from the USCOE.

PART III. RECOMMENDATIONS FOR OVERCOMING THE LIMITATIONS OF THE KELLY REPORT

An independent and critical analysis of the economics of the project, including real estate, and benefit to cost analysis is urgently needed.

All the questions that have been formulated regarding the assumption of hydrological and economic models need responses (see the appendix for hydrological questions).

Alert the University community about the proposal to use lands in the Botanical Gardens north as a debris basin and the new diversion of the río Piedras at that location towards the west of its current alignment.

Make sure the Commonwealth Government understands the amendments to the Cooperative Agreement with the USCOE

The bicycle pathway from Lomas Verdes avenue to the San Juan Regional Park opens possibilities for coordination with the Enrique Marti Coll Lineal Park.

The USCOE needs to provide the public with consistent numbers and avoid the discrepancies in the Kelly report numbers between the Executive Summary and the body of the report. Also, less use of undefined acronyms and between explanations of procedures used to manipulate economic data would greatly enhance the value of public reports.

LITERATURE CITED

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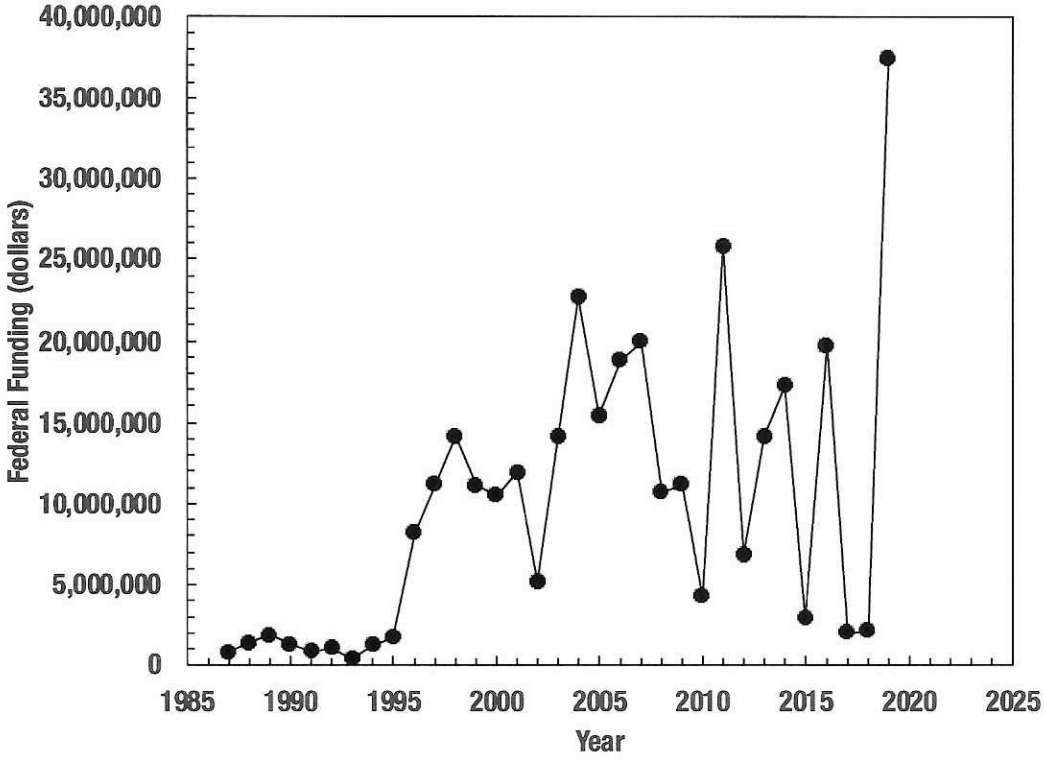
Lugo, A.E., O.M. Ramos González, and C. Rodríguez Pedraza. 2011. The río Piedras watershed and its surrounding environment. USDA Forest Service, International Institute of Tropical Forestry, Rio Piedras, PR. FS-980. 46p.

LIST OF FIGURES

Figure 1. Annual federal funding rate for the río Piedras river flood control project. Data are from Kelly (2020).



APPENDIX

Example of technical questions that require responses so that the public might understand if the procedures used to design the río Piedras channelization are credible and realistic. Similar set of questions are needed for the benefit to cost economic analysis.

- Find more information about the hydrological modeling that was used in the latest iteration of the design and develop key questions we want to be answered by the USACE project team (e.g., assumptions, variables, scale, sea-level rise considerations, etc.) -

I would be interested in knowing the identification of the hydrologic model that is replacing the physical model used previously by the Corps. Once the identification of that model is known, it will be possible to analyze its assumptions and applicability to the río Piedras.
In general, some of the key questions involved include:
The data base used to calibrate the model, how updated it is, how long-term it is.
The topography used, is it updated?
Is the modeling watershed scale or just for the project area? Does it include the behavior of a canalized Caño Martín Peña? And its watershed?
How is sea level rise being handled?
Are extreme events considered?

How much green cover is considered in the modeling? What is the water-retention capacity of the city?
What assumptions does the model have relative to the normal drainage of the city? How effective is that drainage under normal conditions? Under different levels of rainfall?
Is the worse future condition considered? The worse condition would be an extreme rainfall event on land coupled with an ocean surge on San Juan Bay.
Will the box canals be raised as proposed before?
How will critical fluxes be handled?
Is the hydrologic model connected to a sediment and water quality model?
How will canals be self-cleaned?
How will canalization affect the sediment budget of the San Juan Bay, and will it require more frequent maintenance to avoid affecting the traffic of ships in the Bay?